



# HO correctors update

Massimo Sorbi and Marco Statera  
on behalf of the LASA team  
INFN Milano - LASA

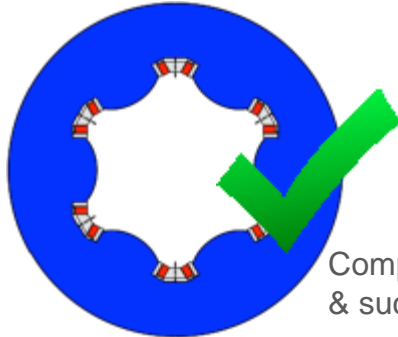
CERN – 8 February 2016

# OUTLINE

- status of the octupole
- status of the decapole
- status of the quadrupole
- status of the round coil sextupole

# MAGNET ZOO (PROTOTYPES)

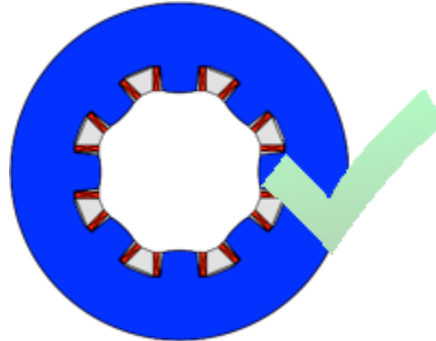
OD=320 mm



Completed  
& successfully tested

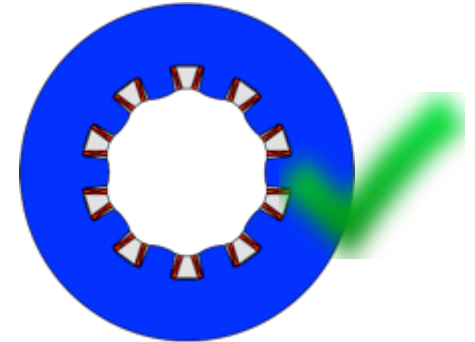
sextupole

OD=320 mm



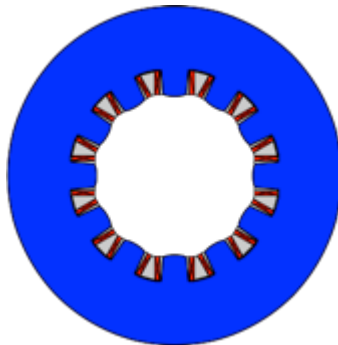
octupole

OD=320 mm



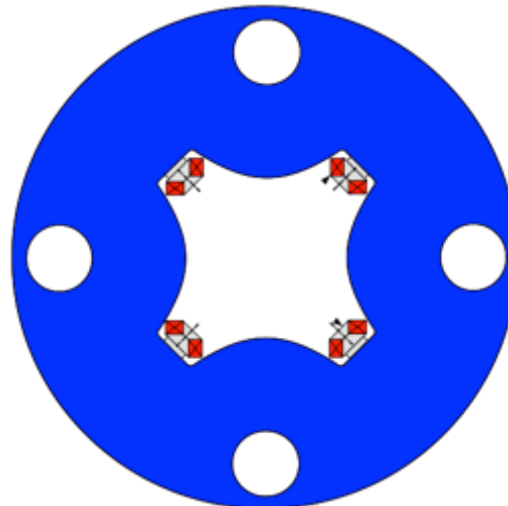
decapole

OD=320 mm



dodecapole

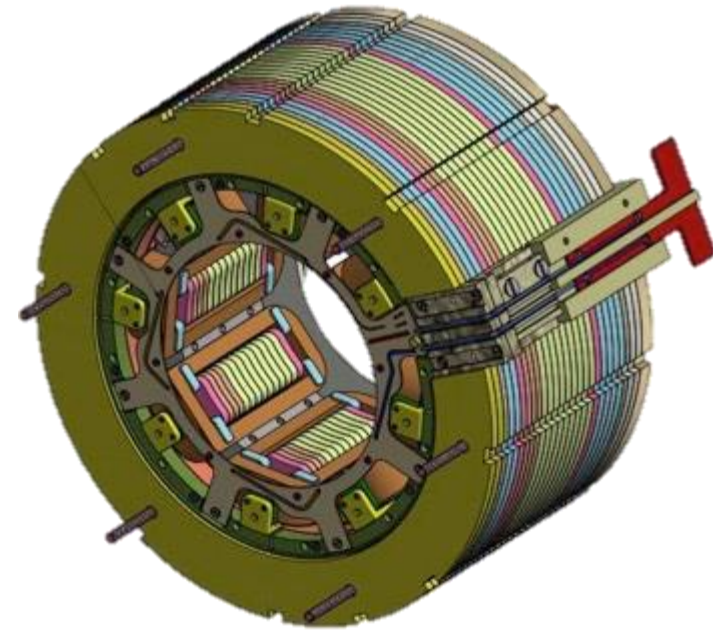
OD=460 mm



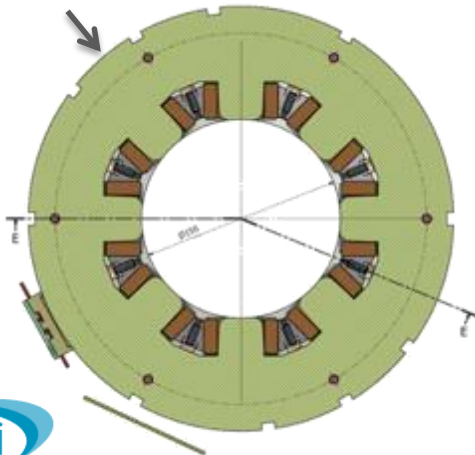
quadrupole

# 8POLE

	nominal	simulation
length	160 mm	183 mm
integrated field @ lop @ r50 mm	46 Tmm	45 Tmm
magnetic length	87 mm	99 mm
energy @lop	1.4 kJ	1.07 kJ
harmonics		B12=11.6 B20=-3.0



$\phi$  320 mm



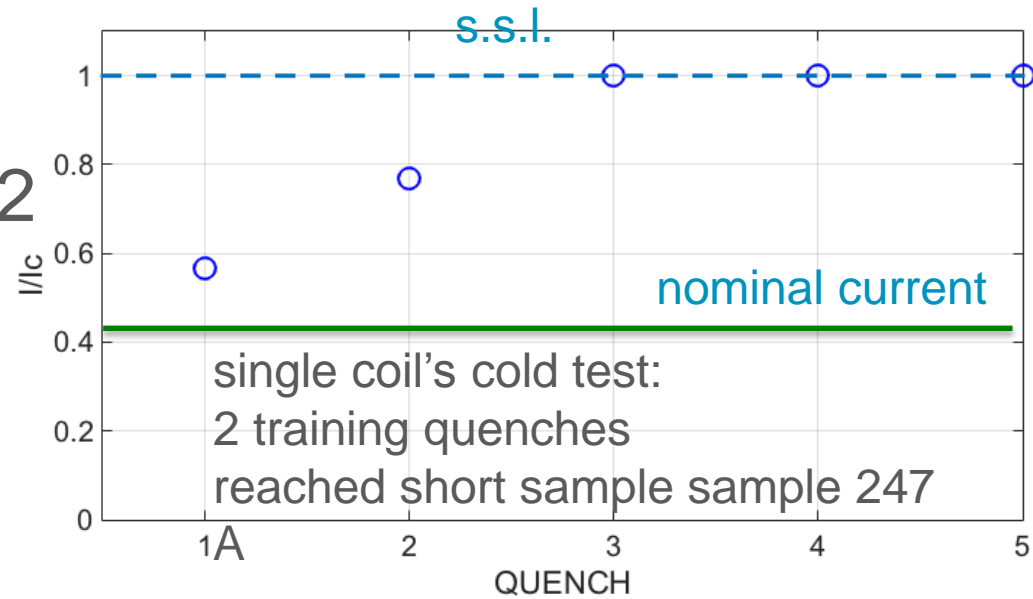
- ELECTRICAL CONNECTIONS
- printed boards to improve high voltage insulation
- DURATRON coils

# 8POLE: COILS

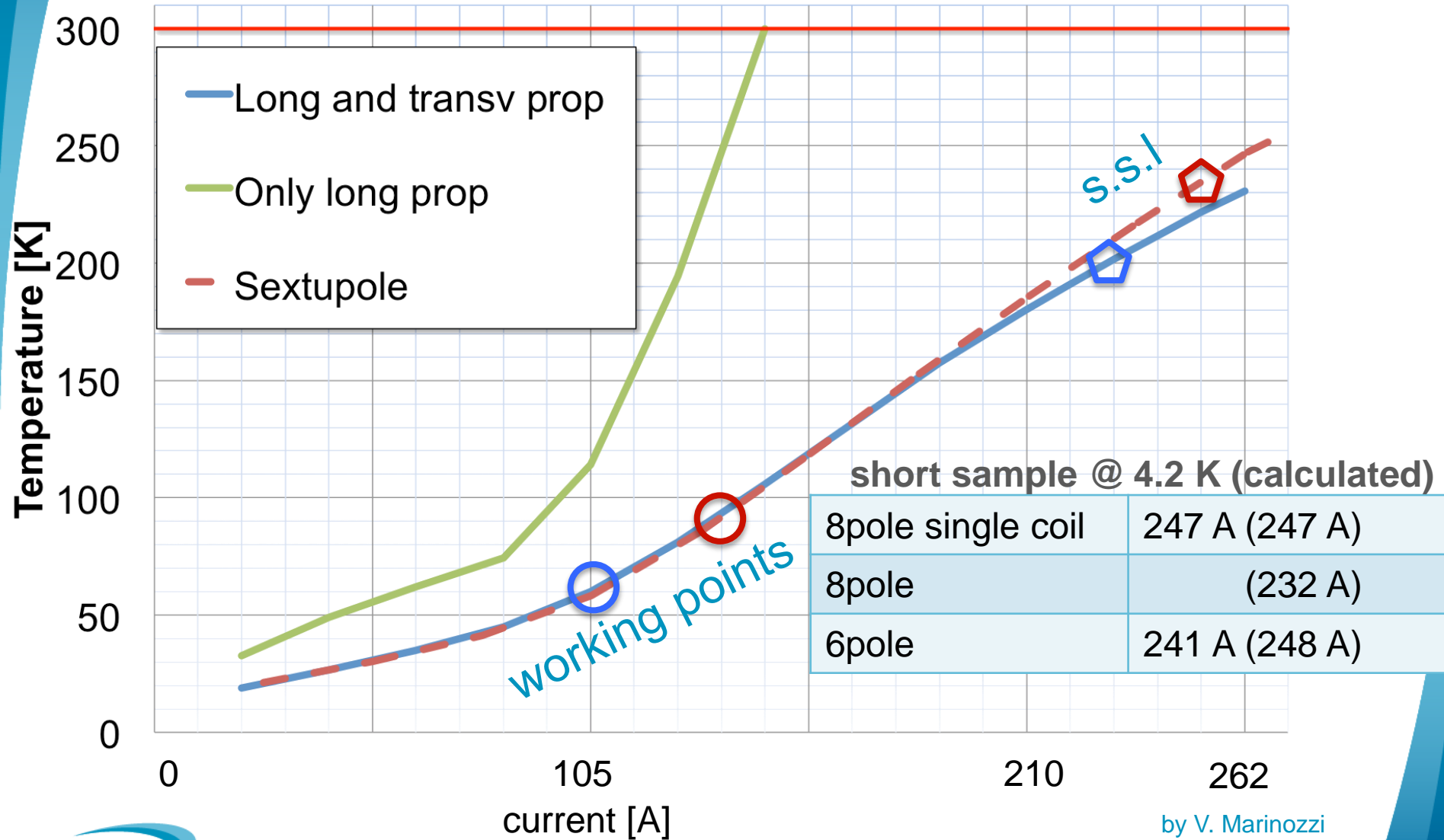
- test coil M08 01÷03
- production M08 04÷12

coils' assessment

- geometry
- resistance
- inductance (2 batches)
- HV insulation 5kV



# 8POLE WORKING POINT



by V. Marinozzi

M. Statera- CERN 2017/2/8



# 8POLE: assembly 1

assembly procedure

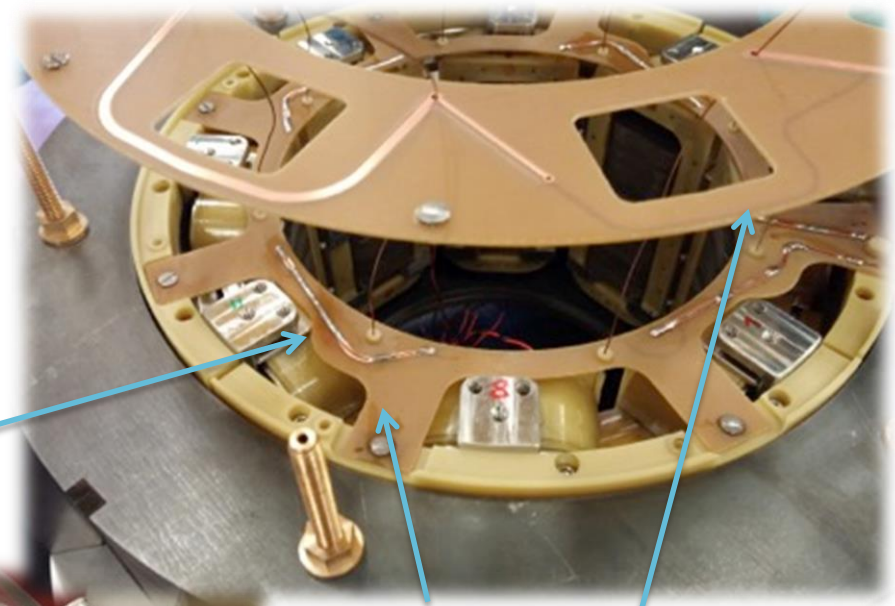
- same as 6pole
- new electrical connections



lamination



Copper 2 mm wide  
0.035 mm thick



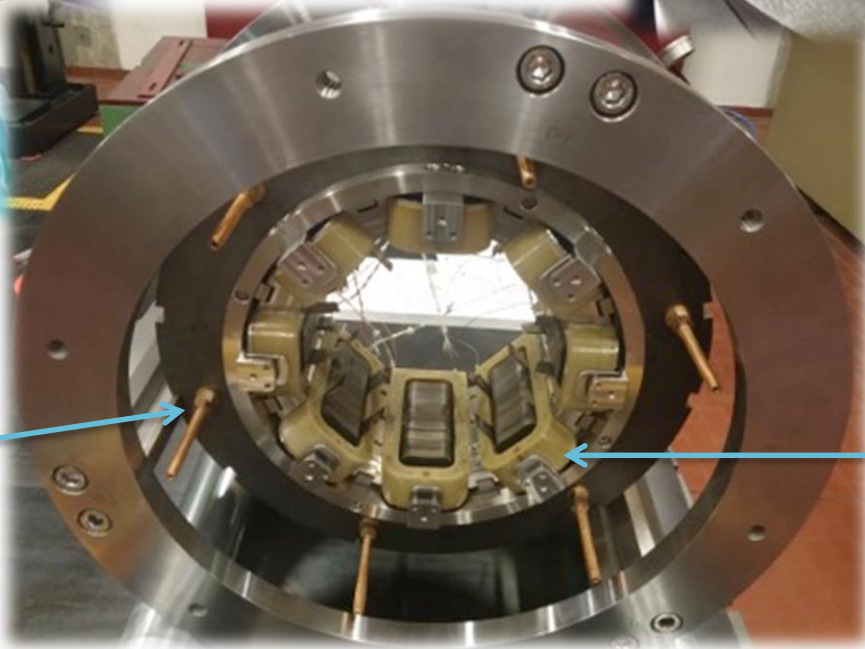
two printed circuit boards

- coils' connections
- signals

alignment frame

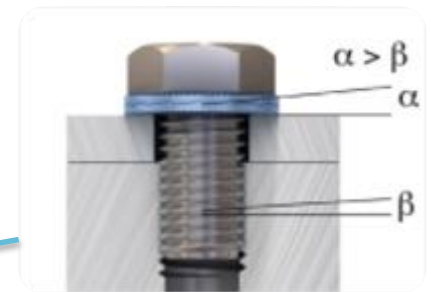
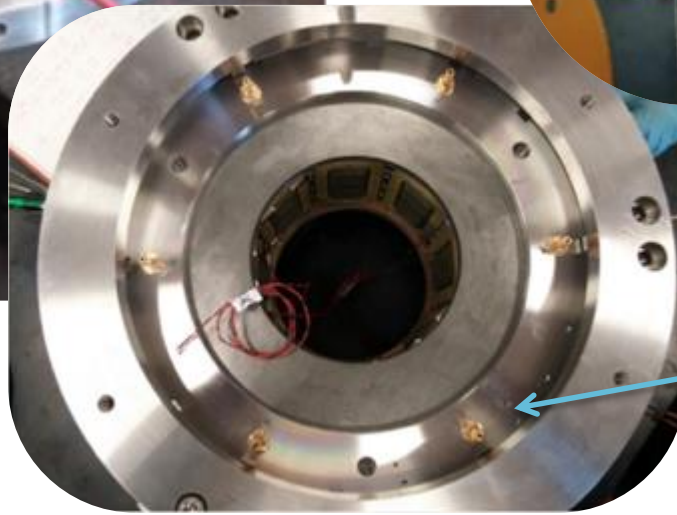
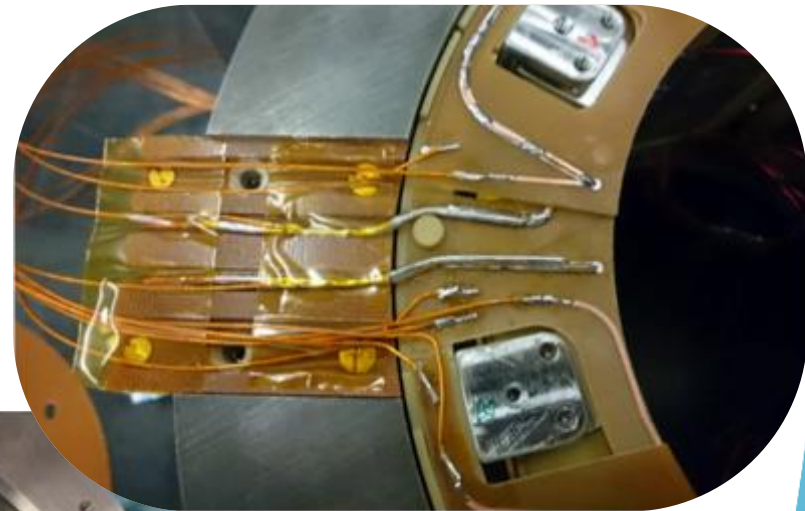
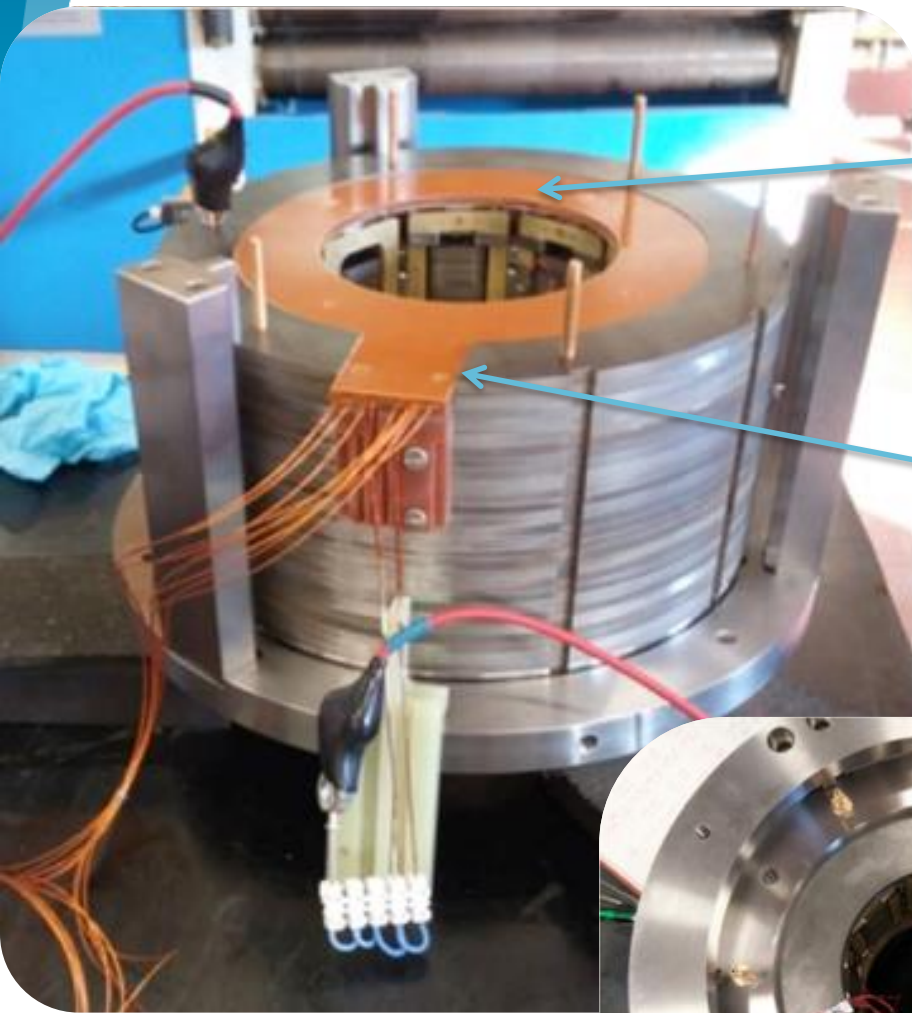


CuBe rods



- spacers
- fixed longitudinally
- wedges in position
- the wedges are fixed

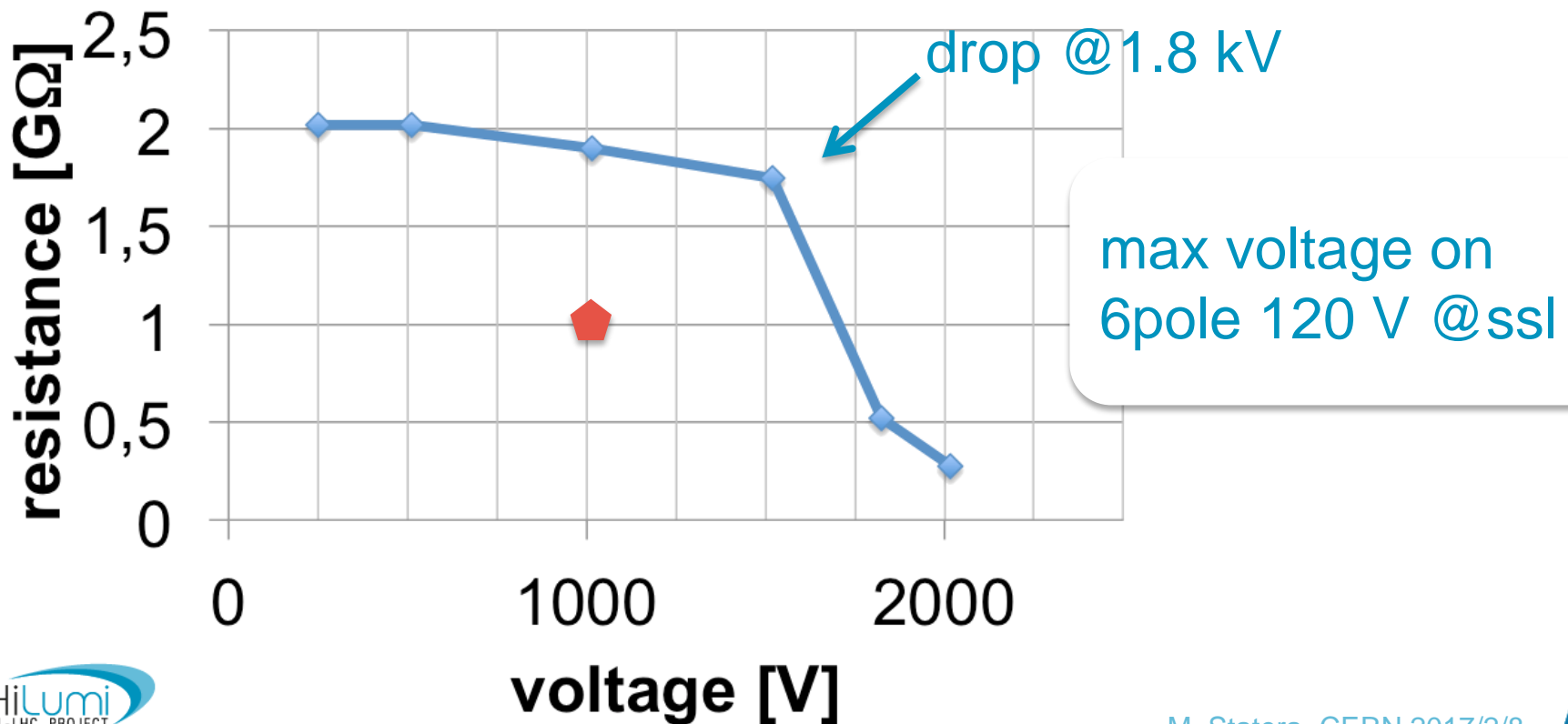
# 8POLE: assembly 2





# 8POLE GROUND INSULATION

- same values during the assembly and at fully assembled magnet
  - coil vs iron yoke
  - circuits and connections vs return yoke
- improvement compared to the 6pole



# 8POLE TEST

weeks 12÷14

- qualification 1h @ 108% @2.2 K
- training @4.2 K
- thermal cycle
- qualification @ 4.2 K



IN MEMORY OF  
GIOVANNI VOLPINI  
1963 - 2016

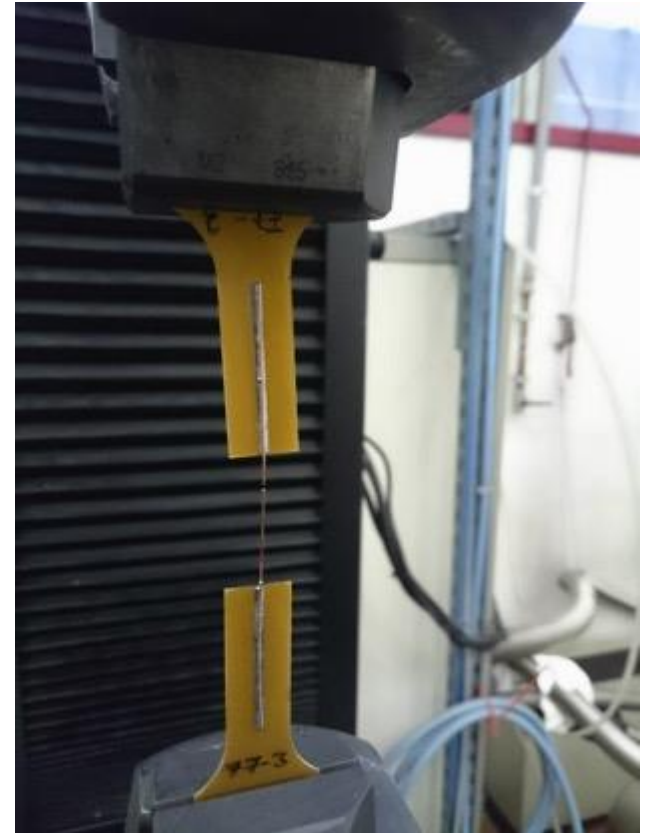
# TESTS

## connections boards (PCB - ARLON®)

- test samples from production
- NbTi wire soldered
- test at room temperature
- w and w/o 77 K thermal cycle
- no Cu or NbTi detachment
- no difference was measured

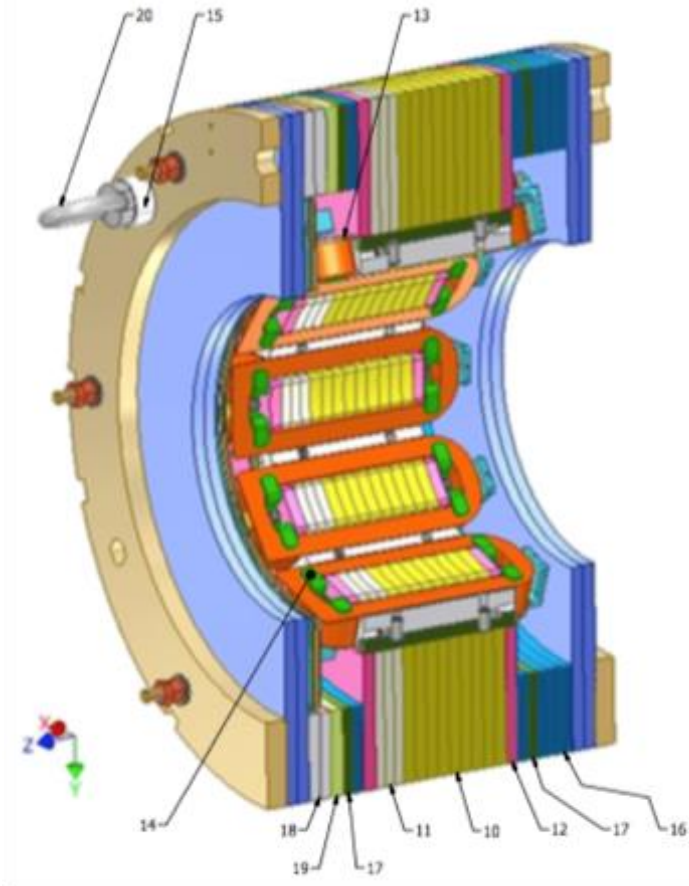
## thread fixing

- CTD101K
- no heat treatment
- 4 weeks: same torque as LOCTITE® 243™
- thermal cycle during next cooldown



# 10POLE

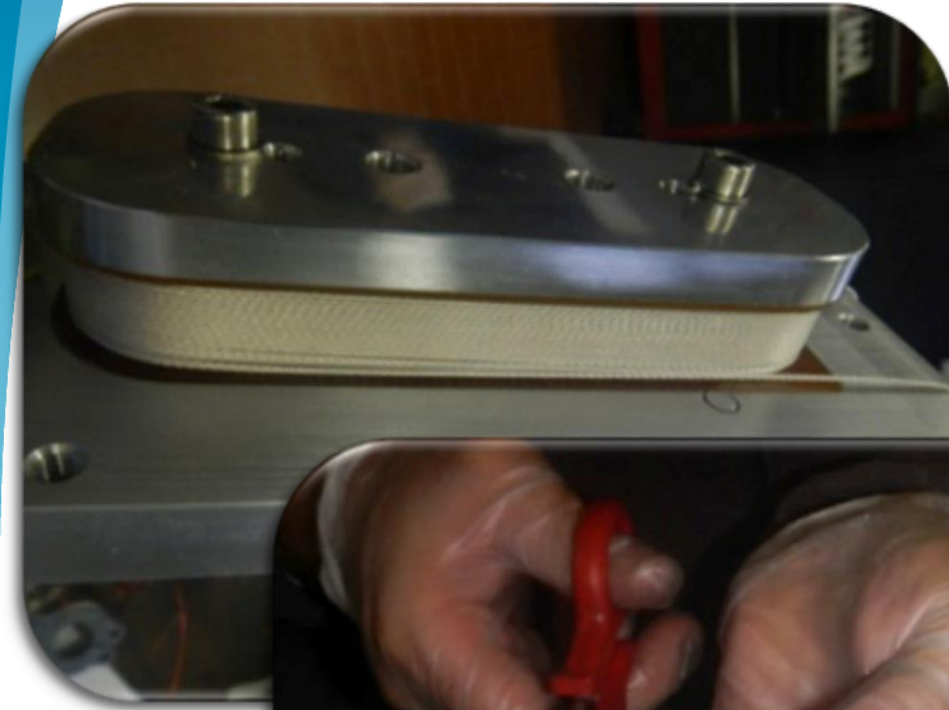
	nominal	simulation
length	172 mm	183 mm
integrated field @ $I_{op}$ @ $r=50$ mm	25 Tmm	26 Tmm
magnetic length	95 mm	97 mm
harmonics		B15=11.6 B25=-0.7



- mechanics procurement ongoing
  - production foreseen in weeks 7÷15
- coils: production started
  - first batch: 3 standard BTS2 + 1 hybrid BTS2/DURATRON



# 10POLE COILS' FIRST BATCH



4 coils produced



# 10POLE COILS' FIRST BATCH - 2

- 4 coils produced (1 batch)
- 3 standard BTS2
- 1 hybrid BTS2/DURATRAN

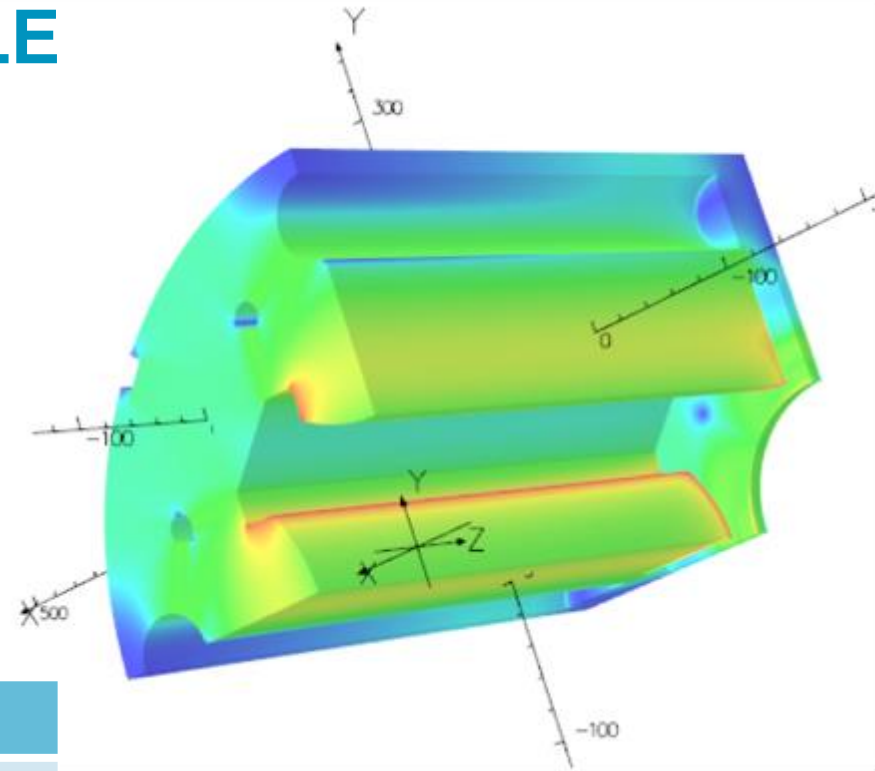


week 8

1 coil full energization  
2 coils thermal cycle

# 4POLE

- electromagnetic design  
 $I_{op}=182\text{ A}$
- protection: ongoing
- mechanical design: ongoing  
total length  $\sim 960\text{ mm}$



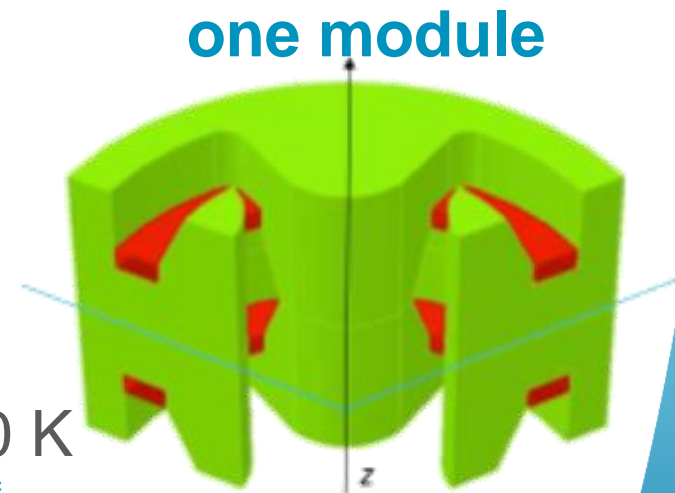
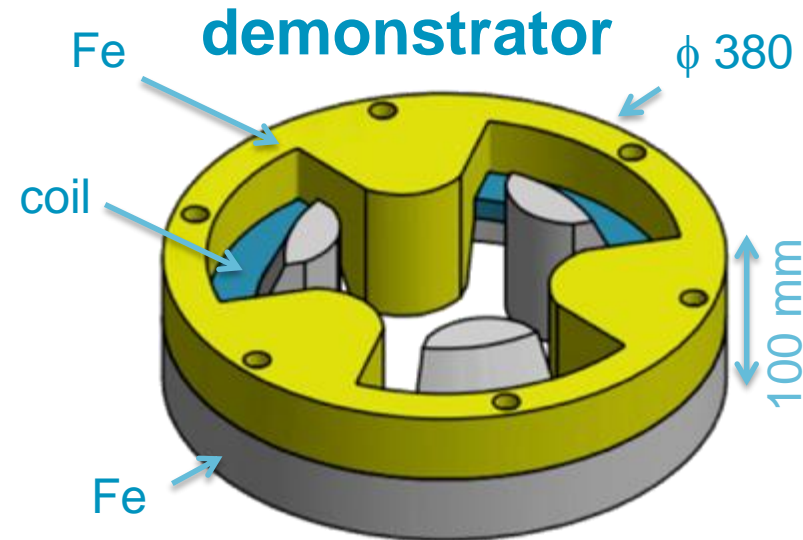
	nominal	simulation
coils' length	839 mm	865 mm
integrated field @ $I_{op}$ @ r50 mm	1.0 Tm	1.2 Tm
magnetic length	807 mm	805 mm
energy @ $I_{op}$	24 kJ	41 kJ

## next steps

- drawings for quotation: this week
- final design: February

# Round Coil Magnet

- demonstrator
- inner bore  $\phi$  150 mm
- single  $\text{MgB}_2$  coil
  - round wire by COLUMBUS
  - bare diameter 1 mm
- electromagnetic design
  - working point 133 A @4.2 K
  - margin 48 % on the load line
  - inductance 148 mH
  - adiabatic hot spot temperature < 90 K



Alknes P. et al. (2015) 11th International Conference on Materials & Mechanisms of Superconductivity. To be submitted as a manuscript to SUST.

K. Konstantopoulou et al.. (2016) Supercond. Sci. Technol., 29, 084005.

G. Volpini et al. Eletromagnetic Study of a Round Coil Superferric Magnet, IEEE Tr. App. Sup, 26, 4 (2016)

# CONCLUSIONS

- octupole: assembled and ready for low temperature test
- decapole
  - mechanics ordered
  - coils in production
- quadrupole: design for quotation
- round coil sextupole: updated design for  $\text{MgB}_2$  wire